ENGINEERING EDUCATION

Bulletin of the

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee.
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Vol. XIV Lancaster, Pa., June, 1924 No. 10

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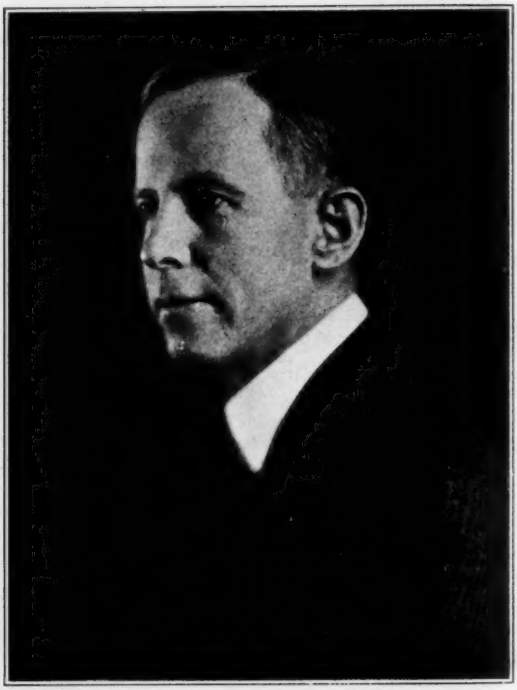
GEORGE NORLIN.

President George Norlin, of the University of Colorado, was born in Concordia, Kansas, April 1, 1871. He received the A.B. degree from Hastings College, Hastings, Neb., in 1893, and following his graduation was instructor in Greek in his



Alma Mater until 1896, when he went to the University of Chicago as senior fellow in Greek, remaining there until 1899, when he was appointed Professor of Greek at the University

of Colorado. The degree Ph.D. was conferred upon him by the University of Chicago in 1900. Taking leave of absence from the University of Colorado, Dr. Norlin spent the year 1901 as a research student at the Sorbonne, Paris. Dr. Norlin was Professor of Greek in the University of Colorado from 1899 to 1917, acting President during 1917 and 1918, and has been President since 1919. The degree LL.D. was conferred upon him by Colorado College in 1920 and by the University of Missouri in 1921. He is a member of Phi Beta Kappa, Phi Gamma Delta, and a contributor to popular and scientific publications. He is now engaged in a translation of the works of the Greek orator Isocrates for the Loeb Classical Library.

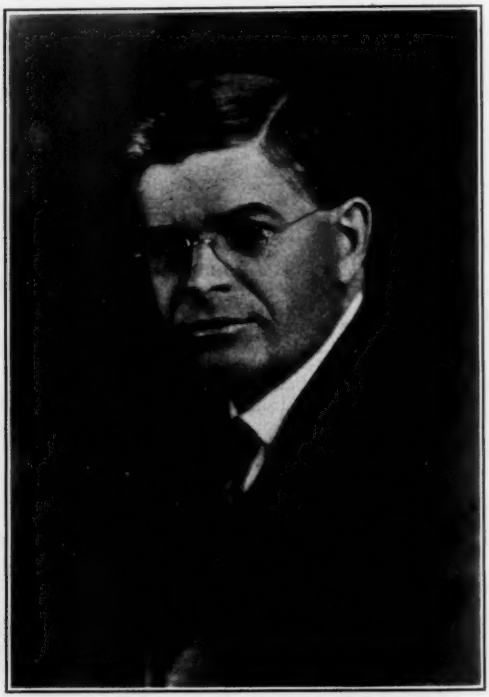
During President Norlin's administration the University has grown in size, expanded its scope, raised its standards, and extended its campus.

As a teacher for seventeen years at the University, Dr. Norlin was universally admired and beloved by his students. As President he has retained his sympathy for students and his willingness to interest himself in their affairs and problems. Always accessible, always considerate, always fair, he enjoys the confidence and esteem of the great University family.

Though his early experience was in a distinctly classical atmosphere, Dr. Norlin has displayed exceptional administrative abilities since he has become President. His ability to keep in tune with the academic phases of University problems and at the same time to understand and cope with the practical things which must be met by the president of a state-supported University, and his capacity for handling many difficult problems without losing poise and cool judgment make him the exceptional University president that he is.

DEAN HERBERT S. EVANS.

Herbert S. Evans, Dean of the College of Engineering and Head of the Department of Electrical Engineering of the University of Colorado, was born in Richardson County, Nebraska, on July 20, 1875.



After his early education in the local schools, he attended Morrill College, Kansas, for one year, 1891–1892; and then took up the study of Electrical Engineering at the University

of Nebraska, where he received the B.S. (E.E.) degree in 1898, and the E.E. degree in 1900. While working toward his E.E. degree, he was in charge of the electrical work for the C. B. & Q. Railroad in Nebraska, continuing his work until 1901. At this time he was appointed instructor in electrical engineering at his Alma Mater, and was later promoted to adjunct professor.

In September, 1905, after a summer with the General Electric Company at Schenectady, New York, he was appointed Professor of Electrical Engineering and head of the department at the University of Colorado. This position he held until the fall of 1919, when, upon the resignation of Milo S. Ketchum, he was chosen Dean of the College of Engineering. As head of the College, Dean Evans came especially well qualified, for he had been acting dean during 1909–1910, and again during the trying war period of 1918–1919. At this time, too, he demonstrated unusual administrative ability as Director of all the S. A. T. C. activities at the University of Colorado.

In addition to the work of his immediate position, Dean Evans always has shown a broad, active interest in his profession, and in state and local affairs. He is a member of the American Institute of Electrical Engineers, and past chairman of the Colorado Section; a former chairman and present member of one of the technical sections of the National Electric Light Association; member of the membership committee of the American Electro-Chemical Society; former vice-president and present member of the Council of the Society for the Promotion of Engineering Education; and a member of Sigma Xi, Tau Beta Pi, and Sigma Tau. He has, furthermore, contributed numerous articles to engineering publications.

MINING SESSIONS AT THIRTY-SECOND ANNUAL MEETING.

Mining Session at Colorado School of Mines, Golden, Colo., Wednesday, June 25, 2:00 P.M.

Under auspices of Committee No. 14, Metallurgy, C. H. Fulton, Chairman, and Committee No. 18, Mining Engineering, G. M. Butler, Chairman.

2:00 P.M. Address of Welcome, Victor Alderson, President, Colorado School of Mines.

The Teaching of Mine Accounting. C. R. Forbes, Missouri School of Mines.

The Economic Side of Coal Production in the Western Fields. C. M. Young, University of Kansas.

Discussion.

On Thursday morning, June 26, at 9:00 P.M. the following papers will be presented at the first session at the University of Colorado, Boulder, Colo.

Metallurgical Education. Dorsey A. Lyon, Bureau of Mines, Washington, D. C.

The Development of Mining Engineering Education since 1910. G. M. Butler, University of Arizona.

Discussion.

CONFERENCE ON THE RELATIONS OF THE ENGINEERING SCHOOLS AND THE NATIONAL ENGINEERING SOCIETIES.

BY W. E. WICKENDEN,

Director of Investigations.

When one begins a study of that realm of men and work known as *professional life* he finds that professions grew out of human needs and came to consist of groups of individuals skilled in the relief of human distress. Society needed to be protected from the exploitation of human emergencies by the incompetent and the unscrupulous, and there were evolved standards of professional recognition designed to guarantee the fitness of the professional man. Since he faced the world as an individual he needed the support and protection of the professional group. Thus it came to pass that professions tended to become close corporations. The priesthood, historically the progenitor of all the professions of individual service, and its modern offshoot the religious ministry, quite effectually control the terms of admission to their ranks. Much the same is true of law, medicine and dentistry.

Control over the terms of admission to the older professions has carried with it control over the educational process which prepares for admission. The standards of the medical schools in the United States are largely set by the American Medical Association. Standards for dental schools are set by a Dental Education Council, in which the American Dental Association, the American Association of Dental Schools and the National Association of Dental Examiners are equally represented. The American Bar Association has a Council on Legal Education and Admission to the Bar which has taken the initiative in formulating standards for American law schools. It is significant that this movement toward standardization and control has been greatly accelerated by the critical studies

of medical, dental and legal education made under the auspices of the Carnegie Foundation for the Advancement of Teaching.

How far is engineering education going in the same direction?

There is a well-founded feeling that the close standardization and control of these fields of professional education has not been an unmixed blessing and that it will be wise to proceed with caution wherever the present study of engineering education touches upon relations with organized professional life. It was on the invitation of this Society that the national engineering societies appointed educational councillors to advise with the Board of Investigation and Coördination on these potentially delicate relations. The Board felt that it would be helpful to include the executive secretaries of the national engineering societies in its conferences with the councillors. The first such conference was held in New York on May 15, 1924.

The conference recognized at the outset that it has no authority and that it does not cover the entire field of engineering organization. Its scope is wholly advisory. It provides a medium for the study and discussion of problems affecting engineering schools and engineering organizations under joint auspices. The conference agreed to undertake agenda of studies rather than agenda of action. It was agreed that the Director's staff, under the guidance of a subcommittee consisting of Mr. A. H. Rogers of the councillors, Mr. C. W. Rice of the secretaries, Mr. J. H. Dunlap of the Board, and the Director, should carry out studies and prepare memoranda on the following topics:

1. The criteria of professional status, with a view to defining more accurately the status of the professional engineer.

2. The present status of relations between other professional bodies, particularly those concerned with medicine, dentistry, law and architecture, and the corresponding groups of professional schools, including the background of the present schemes of standardization and rating of schools by profes-

sional bodies, the evidences of detrimental as well as beneficial results from such standardization, and the present state of relations between engineering schools and engineering societies abroad, particularly in Great Britain and Germany.

3. Minimum standards which may properly be established for the recognition of any institution as an engineering school or any course of study as an engineering course.

4. Standards of educational attainment, in other than technological fields, which should underlie the professional training of engineering students. This would include languages, history, literature, economics and psychological and sociological sciences.

5. Standards of educational attainment in the common group of mathematical and physical sciences and of technological studies which should underlie the professional training of engineering students.

6. Sanctions concerning the normal length and the degree of specialization of engineering curricula to which the societies represented may be willing to give support.

7. Sanctions concerning the desirable qualifications of teachers who deal with professional engineering subjects, their professional and economic status and the appropriate scale of compensation for engineering teachers, to which the societies represented may be willing to give support.

8. The determination of aptitudes as a basis for admission to engineering colleges.

9. The extent to which the relations of the professional engineering societies to affiliated student groups may advantageously be unified or coördinated.

10. The contributions which the profession-at-large and the business and industrial organizations closely allied to it may make to the fund of vocational information relating to engineering and the means which may be employed to bring such information to the attention of parents, teachers and students at the time of selection of a college or university and of a course of general or professional college study.

11. The recognition to be given to graduation from an en-

gineering college in the requirements for admission to professional engineering societies.

12. A survey of the occupational demand for engineering graduates in the more distinctly professional fields, as a complement to the surveys of demand in industrial fields now being undertaken.

The spirit in which these studies are to be undertaken, judging by the temper of the conference, is one of entire open-mindedness. The present state of engineering education is free from discreditable features which might invite drastic action by professional bodies. The precedents set by other professions have no compelling logic. Engineering may represent a type of professional life quite dissimilar to the older, highly individualistic professions and the appropriate scheme of relations between education and professional life may be found to be quite different. The engineering societies may wish to find a means of putting their solid support behind the engineering colleges without any semblance of dictation. It is a situation which calls for frank and sympathetic study on both sides.

There are signs that there is now evolving a new type of professional service which relates to the constructive tasks of society, rather than ministry to individual needs; in which men work in groups and divide responsibility functionally rather than as individual, general practitioners; in which the typical form of compensation is by salary and not by fees; in which the professional group life includes many semi-professional individuals; and in which there is less need of some formal certification of professional competency, than in the older professions which minister to individuals. Engineering appears to stand on ground intermediate between the old and the new in professional life. It appears to need an educational program which will be flexible rather than rigid and yet one which will minister to the development of true professional consciousness and professional spirit.

AT WHAT ARE WE AIMING AND WITH WHAT?*

BY PROFESSOR F. W. SPRINGER.

Among engineering educators there seems to be a lack of agreement as to accepted fundamental principles and methods of teaching. Furthermore our terminology is inadequate. This is in striking contrast to the laws and principles of science which we teach. This criticism applies not only to teaching students in the technical part of their courses, in lecture, class, and laboratory, but more particularly it applies to the methods, or rather lack of them, in training students to be good professional men in respect to ethics and to those habits that make men good citizens and good business men and good leaders.

The principle object of this paper is then to propose a key or outline of educational theory and to make more apparent the desirability and possibility of finding the cues for the application of the theory to engineering education.

The several phases of the problems include:

1. The laws of science and their applications which we teach and upon which we give grades and degrees.
2. The related social sciences and all cultural humanities.
3. The theory and practice of the teaching itself irrespective of the material taught.
4. The practice of teaching as involving the individual teacher's conception of life, its object, success, morals, codes of ethics, and, to some extent, politics and religion.

Success.

We all agree that an engineer must know the technical part or technical facts of his course for this is the part upon which we give grades and degrees, but we must admit that a man to be really successful in applying engineering knowledge must

* Presented at the meeting of Minnesota Section of S. P. E. E.

know also the conditions of life as it is lived and in which engineering principles are to be applied. He should be a fully active individual in the scheme of living as it is.

It is well known that getting all "A's" is not necessarily a sign of success. Many "D" men and even men who have "flunked out" are employing "A" men and consequently we are not justified in recommending graduates in terms of grades only. Graduates are most certainly not selected by industrial employers on a college grade basis at the present time, and they should not be.

We mark students therefore on a very small part of that which makes men good engineers, good citizens, and desirably successful. *Judgment, sustained will power, and courage* have more to do with success than any definite amount of technical training at any time, regardless of grades. A student having the above mentioned qualities which are fundamentally largely inherited characteristics will get what he needs for his particular success where he can, but he will get it. Proved ability to make a long series of correct judgments is what the world is willing to pay for. *Judgment, courage, and will power,* toned up by vision and imagination and strengthened by training and experience, this expresses success always.

Unquestionably engineers often lack the sense of citizenship in that they regard themselves as engineers more than as citizens. Modern conditions are increasingly demanding that the engineer prepare himself in the broader conception of things as well as in the technical part of engineering. As Herbert Hoover says: "If the engineer is going to take his part in this community, is going to give expression to those things that *he* can express best, he must start with a sense of his public obligations as well as his professional knowledge."

The applications of science are increasing in a geometrical ratio with the resulting multiplications of vocations and social divisions; hence the demands upon teachers are becoming greater and more complex in preparing students for the *unknown problems of their futures.* If we regard technical training as difficult, we must face problems still more difficult.

For example, the laws of gravity, electricity, etc., are well understood and can be learned with relative ease. The application of these laws to conditions of life is, however, extremely complicated and varies with the individualism of engineers and of public demand. If now in addition we are to train students to a proper conception of the laws actuating and regulating human relations with the idea that our graduates must know laws both of technical engineering and of life, we have a long hard road to travel; but we may as well admit that travel it we must. It will be much better for the S. P. E. E. to undertake this than to accept a forced investigation by act of public legislation.

Our lack of effectiveness is more evident when we study the methods of selection and training and the psychology used in training football players, track men, violinists, etc. So it is not only that we, as instructors of students, lack that which coachers and trainers have, but what is just as bad, if not worse, is that the students themselves often have not that which football players and musicians have, *i.e.*, the *will to train to win.* Is it not our fault since teaching is our business?

Hardship rather than luxury makes big men bigger. Many fathers who have achieved financial success, in order to protect their sons from the stress and strain they themselves endured, remove from them the very thing that made the fathers strong. It sometimes seems as though we were trying to train hurdlers by sending them over long stretches of hurdles with the hurdles merely painted on the course. A lot of ground is covered at high speed, but the real hurdlers have little chance of being selected and trained for greater heights. Perhaps it is a case of too much predigested mental food and not enough foraging or research and special problems.

Preparation for College.

I quite agree with Professor Brooke that the preparation for college is not now as good, in some respects, as it was 15 years ago, especially in the days of the State Board Examina-

tions. His statement that it is not safe to trust a freshman class in mathematics with the addition of ½ and ⅓ because about 40 per cent. of them would make it ⅖, illustrates the situation perfectly. But when one considers that 84 per cent. of the world's auto-vehicles are in the United States, we realize that these same students have automobile and radio training and culture, with whatever this implies. However, it seems to me that students who survive the sophomore year are better trained than they were 15 years ago, omitting the war period, and do better work in the junior and senior years.

High schools have become baby colleges in which they imitate and accentuate the social life, athletics, fraternities, etc., about which they hear and read so much. At the same time they probably hear little about some of the real serious work that is actually being done in college. This isn't such good reading and receives little attention by high-school students, or their parents. Why should it from their standpoint? Boys usually don't look ahead five years, and things suit them "as is"; *they pass.*

Relatively good incomes and social climbing desires of parents for their children are forcing crowds into the high schools and some of these go with the current into the colleges. The dominating desire of many students seem to be social pleasures and easy living without manual work, however most of *us* secretly or publicly wish we were rich. They do not want to win enough to work for it because many have never found it desirable or necessary to form the *habit of trying,* except that of trying to get some one else to do their work. But these same students are not fools enough to think that some one else can do their training for them if they wish to make the team. Students in general seem to have sense enough to do those things they need to do to get what they want. If they come to us unprepared and leave us unprepared it is perhaps to some extent our fault as teachers. Still, who can say high schools are not doing a lot of good work?

COLLEGE TEACHING.

It is quite evident that there are two ways to put the "drive" into students, one is to sell courses to them so thoroughly that they will want to study in order to acquire power, or second, to use disciplinary force and drive them to survive or sink by enforcing standards. We may use both methods.

There should be no reason why we cannot make the training of engineers as well understood by both instructors and students as the training, for example, in athletics and music. If we look over certain fields, we find that students have no illusions about merely getting by.

It is to be seriously questioned whether high school or college students are in general inferior in potential physical and mental strength to those of a number of years ago. The difference is thought to lie more in what they do and have done in respect to the needs of our college than in what they are as human possibilities. The difference is one of training and selection.

We hear much about the experimental psychological discoveries of individualities of students. The words "individualism" and "individuality" have been well known for a long time and so far as engineers are concerned these qualities seem to have given enough stress. Scientists and engineers, researchers and inventors do not in general need more individualism or its accentuation.

At the last meeting considerable time was given by Professor Parcel to the subject, "what shall we do for the good student?" Of course, the answer is not—nothing. He should be *permitted* to make "A's" instead of "D's." There is a large difference in the amount and quality of work done for the two grades. Two men who hear a lecture, read a book or take a course will get different amounts and different things from the same opportunity, meanwhile they continue, and will continue to live in the same educative community which should fairly represent life. There is no apparent reason why two students of greatly different temperaments and abilities should

not associate both in and out of class and each one develop without restraint.

Above the sophomore year, it is believed that the engineering student taking work for credit with indifference to his improvement is the exception and not the rule. It is well known that students seek those tutors and instructors who will so train them that they pass the examinations. If we make our courses as good as possible, this will go a long way in caring for the good student. We should not induce the ambitious student to overwork. This is not a joke. A percentage of upper classmen overwork each year.

Students in engineering may choose any of several lines of subjects and are given a choice of many groups of subjects and many individual courses. Further, students showing the capacity may take more than the normal amount of work. In addition instructors are on the lookout for the unusual students to take their pet courses.

It would seem that good students and the individualism of students are well provided for in engineering, which is itself an elected course. I am convinced that our problem is to care for both the better and the poorer student by more fundamental changes than by administrational sectioning of students according to their capacity to be filled with technical facts or to memorize principles.

The thing to be done is to go at the educational problem in the engineering way by applying fundamental principles. Take the educational machine apart and rearrange and remodel it to do the new work and the old work in a better manner. This is going to be a continuous process. The mechanism referred to lies in the instructors' and students' minds. We must change our states of mind and attitudes in some respects with the resulting change in our methods. This will result in a corresponding response on the part of students. The *rapid increase in the common use of applied science makes this peculiarly our problem.* How did the hordes of boys and non-scientific business men, lawyers, etc., learn to use the complicated radio circuits? The answer is *interest,* internal drive

or *wants* of these hundreds of thousands. Grades are given for such knowledge in college, but those referred to did not learn radio in college. It is so is every line. We must search for the key and the cue and learn how to use them.

Those who are familiar by experience with the English, German, and French methods of university teaching, *i.e.*, lectures to large groups and the laboratory and library research basis of teaching can see no reason why certain features of such systems could not be applied in the United States. There is no evident reason why a university need continue grade school methods in the upper years of college. Why should the classes of real educators be limited to 25 or 30 at great expense when several hundred could hear and see just as well as a few? In fact there can be no question but that the lecturer develops his maximum educational force under the impelling influence of the approval or disapproval of the larger audience. It is not evident that the other 2,999 take away anything from the one in a theater or church or lecture-hall.

Entrance Standards.

Since we must teach new things in terms of what students already really know, it is desirable that students entering college should meet certain requirements of the particular college in order that the students have this necessary foundation. For this reason it is desirable to teach freshmen in small sections and to begin the process of selection and vocational guidance and elimination immediately.

If students come to the College of Engineering unprepared, it does not matter whether they were poorly taught, or misdirected in the High School, or lazy, a high school diploma, or written or oral excuse, or sympathy will not make up the lack of preparation. It will have to be made up by the students themselves either in the college or elsewhere before they can make satisfactory progress. "Getting a law passed" will not help much in such cases.

It is, of course, understood that the standards of the college,

as to entrance, cannot be set at any point desired solely by faculty action of that college without consideration of the standards of other colleges and of the high schools themselves, but the standards can be set somewhere.

Our attention can now probably be best focused on the various phases of education by stating the situation in a series of eight problems, each accompanied by suitable discussion.

Educational Problems.

Problem 1: Give the methods of selection and elimination of freshmen the most careful consideration and assign best suited teachers to such work.

This problem is complicated by the necessity of blending two seemingly antagonistic viewpoints: one, that we should train engineering leaders only and the other that each line, such as electrical engineering for example, should be used as a vehicle for the general development first, of citizens who may use their electrical knowledge in many major, minor, or indirect ways. This second viewpoint, to be tenable must assume that the real electrical engineers among those students shall be given their chance also and in no way be restrained in their progress.

Problem 2: What constitutes a proper program of courses in the respective branches of engineering? It is pretty well agreed that we are training students that they may have the power to solve the unknown problems of the future and that therefore our limited time should be spent mostly on the fundamentals. What are they?

The way students live, with whom and where, their exercises, pleasures, friends, and in fact all outside of class activities are certainly just as important as those controlled from inside of classrooms.

Problem 3: What part, if any, shall instructors take in these so-called outside influences, and how can these outside factors be systematically recognized, measured and used?

After a freshman student has been passed as suitable, then

the work should proceed on improved methods of teaching and at the lowest cost to the state. It is believed that Mark Hopkins and the log has been very much overdone as a slogan. No university is wealthy enough to run a college on a Mark Hopkins'-log, or father-and-son basis, except for very short intervals in needy cases.

Problem 4: Why should we not handle large class sections in the upper years on the educational rather than the teaching or tutor basis, making use of the short *daily* written recitations, lectures, experimental demonstrations, and quizzes, quizz sections, discussions on an engineering meeting basis and calls for questions?

Help in correcting papers and problems can be supplied by assistants and teaching fellows some of whom will at the same time be serving an apprenticeship as teachers and educators.

Where daily credit is given for work done by students, it is suggested that calling rolls, accepting written or oral excuses for absences or in any way suggesting or indicating an alibi for work is bad psychology. If a violinist fails to practice his scales, no matter how good the excuse, the practice still remains to be done and that is the idea to keep before students always. If sufficient work is not done, it is not done. One can, of course, be sorry, sympathetic, and helpful, but still the work is "as was." There is no escape in the long run. *Students must learn this: ideas, suggestions, and information may come from any source, but the students eventually acquire as theirs only that which they work and think into their own minds.*

It is well known that laboratory courses can be handled in larger and larger sections, in a given line of work, from the sophomore year up. Research work, however, is limited by the problems or the work itself rather than by number of students so that no one instructor can handle a very large number of students doing original work.

Problem 5: Study the graded sizes of laboratory sections to reduce costs without loss of efficiency.

Problem 6: The question has been raised by many, President

Hadley for example, as to the relative value of cut and dried courses and experiments as compared to research, even in undergraduate years.

It would seem that a diploma has become a label, not of power to solve the unknown problems of the future, but rather a label indicating that the graduate is a package containing a minimum number of a certain kind of facts and memorized principles, and not guaranteed at that.

We may use the same fundamental principles of life and of teaching in kindergarten and colleges, but manifestly we should not use the same methods. It would seem that we are, in many cases, carrying the recitation of the eighth grade school too far and too high in college work. A class of men, some of whom have wives and babies at home, will grow best when considered and treated as men. This should not be considered for a moment as proposition to let down standards. If our courses could be given more on the "take it or leave it" basis, especially in the upper years, that students who should not continue a course, would drop out by not even appearing for the finals, thus illustrating the law of *educational gravitation.* This is the continental method and it works—in Europe. We learn too much from European engineers, even with their limited opportunities of application, to discount their methods of engineering education.

Problem 7: We should agree upon what are the fundamental principles of education and see to it that these principles are condensed and arranged so that instructors may use them and more easily find out why some teachers are far more successful than others and thereby appropriate, as far as possible, the successful methods of others.

As a start on Problem 7 the following is offered: Each one of us, and every student, is now what he was born plus what he has done and what has been done to him since he was born. At birth he represents the composite, or a sort of summation, of all the influences of heredity and environment affecting his successive series of ancestors clear back to the beginning of

life on this planet or on some other planet and perhaps further back than that.

What each of us is going to be will be determined by what each is now and as affected by the forces within us and these forces which affect us from without. This epitomizes life, of which education is a continuous part.

Huxley once said, "The great object of life is not knowledge, but action," evidently meaning that the great thing in life is *applied* knowledge, that is, creative knowledge for the betterment of life.

Repeated mental and physical actions and continued physical and mental states always lead to habits. What we are or may become then is a combination of heredity and the habits we have formed by reason of compulsion or desire in our particular environment.

What we each are now and what each student is now as to character, temperament, knowledge, and skill, etc., is a *bundle of mental and physical habits woven into the individual's hereditary fabric.* People differ primarily because they are born different.

These individual bundles of habits are manifestly colored, characterized, and determined by hereditary tendencies, or inherited characteristics, combined with the external factors of each individual's environment of which we teachers are a very small part in the case of an individual student. But one instructor can and may be a very effective and important part.

It is the problem of the instructor or trainer to induce, force or cause the student himself to jump higher and higher hurdles, always starting with student's present jumping power or present knowledge and to lead the student to go through stiffer and stiffer lines, to solve harder and harder problems; to repeat and repeat till the desired habits are formed. There is no easy way to "practice makes perfect" but there are effective ways to accomplish this. A successful musician, football player, mathematician, or great engineer results from first, proper hereditary attributes, and second, proper habits

resulting from repeating proper mental physical actions under proper conditions.

It would seem that our problem would be to study methods of selection insofar as is practicable because it is manifestly impossible to make any desired kind of a professional man out of any kind of student, next to study all factors that have to do with the formation of the desired mental and physical habits to develop first the citizen and second the specialist part of each student.

We have a double problem, first to train ourselves, individually and collectively, and then to do the similar thing to students.

It is believed that the fundamental principles briefly indicated above can be outlined and illustrated so as to be generally useful by instructors so that in five or ten years positive results may be obtained.

We must, of course, have an educational organization or machine, standards, limits, rules, discipline, and use if necessary fear and force as well as the individual wants of the students as the motive power in inducing proper actions in order to acquire proper habits.

However, if we could take twin students, exactly alike, properly selected in a course and train one by the use of fear and force and the other by inducing proper desires in the student by the directing of environmental pressure, we could likely develop two men having substantially the same knowledge of facts. The question is, which one would be best trained to fit into society? The point is that while we are training for one thing we acquire also a lot of related and associated habits.

We should ask ourselves why it is generally so much harder work to push a wheelbarrow or a lead pencil than it is a football.

An engineering teacher usually learns his trade, so far as the teaching part is concerned, by working under the direction of a master teacher or professor. Teachers in general know the subject matter they teach, but it cannot be said that a large percentage understand thoroughly the process of assimilation

of knowledge in the way that a physician knows not only foods and food values, but also the process of digestion.

In order that a teacher may be most effective, he not only must have the materials for lecture, recitation, and laboratory, but he should understand and use or direct the natural law factors indicated in the following list of parts or elements of a mental machine stated in the order of operations.

The operator, or teacher, supplies the materials of knowledge, adjusts and directs the desired environmental pressures and educational production follows.

When teaching becomes more consciously scientific, we shall direct laws of nature in educating engineers just as we apply certain other laws of nature in the practice of engineering. In the latter we have units and methods of measurement as well as terms and definitions. This is not true in the former as yet, so that we must continue for a time with the hand-operated-non-automatic system, when as a matter of fact it is a possibility that education could be done by the most beautifully automatic and complicated arrangement, entirely self-driven. The teacher provides and "sells" the material of knowledge to the student, and also inspires, "sells," directs, or "supplies" the motives or motive power of the student.

THE EDUCATIONAL LAW FACTORS, MACHINE, PROCESS, SYSTEM OR SEQUENCE.*

A {
(1) *Heredity:* family tree, hereditary traits, inherited rights, and
(2) *Environment:* environmental pressure of everything affecting the senses, including everybody and everything within range of observation or of the senses.
}

The above, (1) and (2) result in

* *Minnesota Alumni Weekly*, 1911–12; BUL. S. P. E. E., Vol. III, No. 3, Nov., 1912, etc.

B
- (3) *Stimuli:* internal and hereditary tendencies and external stimuli from environmental pressures above. These cause
- (4) *Wants:* needs, necessities, demands, desires, intuitions, ideas, interest, attention, temptation, ambition, imagination, motive, concentration, determination, and will power.

These are followed by

C
- (5) *Actions:* both physical and mental meeting
- (6) *Limits:* includes all obstacles of all kinds, rules, regulations, laws, standards, traditions, prohibition, competition and self-preservation, conscience, fear, force, punishment, and pain—all limits set by nature and society.

(5) and (6) combined result in

D
- (7) *Experience:* real and imaginary, and then, foresight, initiative, self-reliance, and judgment result from success and failure of action.
- (8) Repeated mental and physical actions, or practice, result in
- (9) Mental and physical habits, good and bad, or
- (10) *Knowledge* and skill and states and attitudes of mind, including memory and inertia of habits.

All habits added to hereditary traits are what we are. This includes not only memory tracts of the brain, but the lines of one's face, and characteristic physical manners as well as mental and temperamental traits.

The above is submitted as *a* key to problem 7, the theory of education. It contains cues for the application of the theory to engineering education. This should be the subject of another paper, which should include systematized groups of illustrations of the successful application of the theory.

It is well known that some people, including teachers, seem to have a knack of doing certain things, hence it is quite pos-

sible that many teachers are particularly successful in certain respects because they have "just naturally" properly directed educational forces without much thought of formulating the methods. Such teachers and others would, no doubt, be glad to contribute ideas and methods to be formulated by a committee for the benefit of all.

Problem 8: Arrange a list of methods of teaching in logical order, which are successful in application as well as correct in theory.

Education and Business.

The "wants" above are synonyms of the "demand of the *law of supply and demand, which ultimately always fixes values.*" With no want there is no value even with small supply. While "wants," used as an *educational force,* may be measured and expressed in dollars as in case of the demands of commerce, it is thought to be unwise to do so as it would tend to lower the tone of public service and of qualities that are related to higher culture. It would be bad policy and bad practice to stimulate students to get more education solely to earn more money, unless getting more money be immediately connected with the use of it for the general good.

It seems to me that the way to meet bunk and demagoguery of political and social life is to get down to fundamentals, first in education, then in politics. It is time to start something when one hears so many people claiming that the world owes them a living, advocating the fixing of wages by law permanently in terms of needs or wants and not in terms of value of service, or production or supply and demand. To each according to his need, leads eventually to a game of grab on a guerilla basis. It is time. Let's go!

Committee.

It is hoped that the Minnesota Section of S. P. E. E. will appoint a committee of ways and means to plan some method of approaching these problems.

In solving the proposed problems, all factors of all of them must be considered together.

This presentation of our problems is believed to be in line with University policies, hence it would be a mistake to close this paper without reference to statements regarding educational problems made by President Coffman in the *Sunday Journal* of March 2. I have taken the liberty of particularly calling attention to a few paragraphs:

"The University should train young people to get more richness out of life. If one is trained adequately in law, medicine, nursing, teaching, or any other profession, and as a result of his training has been imbued with the ethics and spirit of his craft so that he dedicated his life primarily to service and citizenship rather than to personal gain and to the accumulation of a fortune, he has, it is maintained, all of the benefits of any liberal program of education.

"Four factors are responsible for the failure of many students in college:

Sheer lack of intellectual ability.
Absence of certain necessary moral and character qualities.
Ignorance of what it means to work, and of how to work.
Lack of a definite objective.

"I agree that the incompetent should be eliminated. Where to draw the line is the question. But wherever it is drawn, those who pass beyond should be permitted to choose a curriculum corresponding to their abilities and desires.

"Some of these curricula will be less than four years in length.

"The efficiency of our higher institutions of learning in the future will not be determined by the number they eliminate, important and necessary as that matter may be, but by the extent to which they guide students wisely, train them in proper habits of thinking, become interested in their individual abilities and welfare, reorganize the materials of instruction, improve their methods of teaching, introduce programs of work adapted to modern society and to the need of students, and remain close to the people.

"The coming of large numbers to the University is not a thing to be deplored; it is a most fortunate sign.

"It is a question whether lecture courses, with quiz sections which provide for large numbers of students at less expense, have resulted in decreased educational efficiency.

"Classes of 15 or 20, or not more than 30 students, give the best results according to prevailing opinion, but there is no concrete scientific evidence to support this opinion.

"Studies on this point, in the public schools, show that size of class furnishes no index of the probable achievement of pupils. One educator said that instead of spending so much time looking for the optimum-sized class, we should look for large class teachers.

"The American creed is that every man should receive such education as his circumstances and ability will permit him to profit by.

"In making a man it is our business to make him a good citizen and at the same time to make him good for something."

ENGINEERING COURSES FOR THE FUNCTIONAL RATHER THAN THE INDUSTRIAL DIVISIONS OF ENGINEERING.

BY EDWARD BENNETT,

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1. Purpose.

Perhaps the most serious, clear-cut, and specific criticism which can be made of the existing courses of engineering study is to the effect that they bring new topics to the attention of the student in such numbers and with such rapidity that he cannot adequately meditate upon, or review and correlate the flood of new half-formed ideas. The result may be the formation of the habit of confused or of superficial thinking.

Now, strange to say, in a number of the discussions of engineering education, the superabundance of the subject matter which may be offered in a specific course, or the "congestion" of the specific course, (for example, Civil Engineering, Railway Option) has been attributed to what is termed the subdivision and *specialization* of the engineering courses of study. Other undesirable effects, such as narrowness of vision, have been attributed to *specialization*. These imagined evils of specialization have been so persistently presented that the tendency in more than one college is to make all the engineering courses of study identical in content for one, two or three years for the entire group of engineering students. As a matter of fact, at the present time, all the engineering students at any given college have substantially two years of work in common, the greater part of which occurs during the first two years of the four year courses.

In striking contrast to these courses, this paper presents for consideration courses of study in which the fundamental studies of the first two years are not identically the same in all

courses, but are avowedly different both in content and in aim. Each of these courses is intended to provide the foundation for what may be designated as one of the *basic types* of engineering work or as one of the *functional divisions* of the engineering field. In this paper, the functional divisions of engineering are considered to be the functional divisions found within any of the large industrial organizations. These divisions are listed and specified in Table I.

TABLE I.

BASIC TYPES OR FUNCTIONAL DIVISIONS OF ENGINEERING AND PROPOSED ORGANIZATION OF THE ENGINEERING COURSES.

(Emphasizing the functional divisions of engineering.)

I. *Engineering Research:*
   - *A.* Of the analytical—physical type—Faraday.
   - *B.* Of the analytical—mathematical type—Heaviside.

   Majors:
   Thermodynamics.
   Electrodynamics.
   Metallurgy.
   Physical Chemistry.
   Organic Chemistry.
   Mathematical analysis.
   Hydrodynamics.

II. *Engineering Design:*
   - *A. Of appliances and machines:*
     - *a.* Manufacturing features.
     - *b.* Mechanical features, stress, deformation, vibration, friction.
     - *c.* Electrical features.
     - *d.* Chemical and thermal features.
     - *e.* Thermodynamic features.
     - *f.* Hydrodynamic features.
   - *B. Of structures:*
     - *a.* Foundations.
     - *b.* Steel structures and frame works.
     - *c.* Reinforced concrete.
     - *d.* Ships.
   - *C. Of Plants or systems:*
     - *a.* Industrial plants (mills, metallurgical, chemical, textile, etc.)
     - *b.* Steam power plants.

c. Gas plants.
d. Hydroelectric plants.
e. Mining plants.
f. Systems of communication.
g. Systems of transportation.
h. Systems of remote control.
i. Systems of power transmission.
j. Heating and ventilating systems.
k. Sewage systems.

III. *Engineering Supervision.* (Having oversight of physical plant and physical and chemical processes.)
A. *Manufacture of materials, machines and appliances:*
a. Inspection and test.
b. Master mechanic.
d. Plant engineer.
e. Plant chemist.
f. Service department.
B. *Construction, erection or installation:*
a. Excavation and tunneling.
b. Railway construction.
c. Building construction.
d. Bridge construction.
e. Dam and flow line construction.
f. Highway construction.
g. Power line construction.
C. *Operation of Utilities:*
Maintenance and operating engineers in
a. Transportation systems.
b. Power supply systems.
c. Gas supply systems.
d. Water supply systems.
e. Systems of communication.

IV. *Engineering Management.* (Having oversight of artisans, machine operators, and the business features in the engineering industries listed under engineering supervision; viz.,
A. Manufacture of materials, machines and appliances.
B. Construction or erection.
C. Operation of Utilities.

V. *Engineering Sales:*
A. Of engineering materials, (wire, oils, steels, cement, etc.).
B. Of service (transportation, communication, power).
C. Of machinery (electrical, mining, steam, hydraulic, mill, excavating, pneumatic, gas, ventilating, etc.).
D. Publicity.

2. The Existing Courses of Study.

Table II shows the customary lines along which the engineering courses of study are at present organized in the majority of the Engineering Colleges of the country. The course in architecture is not listed or considered in this paper since its content is very different from that of the other courses.

TABLE II.

The Existing Courses of Engineering Study.

(Emphasizing the industrial divisions of engineering.)

I. *Civil Engineering:*
General; Railway; Structural; Sanitary and municipal; Hydraulic; Highway; Reinforced concrete; Architectural Engineering.

II. *Mining and Metallurgical Engineering:*
Mining; Geological; Metallurgical; Ceramic.

III. *Mechanical Engineering:*
General; Machine design; Steam power; Internal combustion engine; Automobile; Aeronautical; Textile mill; Heating, ventilating and refrigerating; Industrial management; Ordnance; Marine engineering; Railway mechanical.

IV. *Electrical Engineering:*
The catalogs rarely have the elective studies in the electrical engineering course grouped into options.

V. *Chemical Engineering:*
General; Gas and fuel engineering; Organic industrial; Pulp and paper manufacturing; General chemical manufacture; Electrochemical.

VI. *Administrative Engineering.* (Also called Industrial Engineering and Commercial Engineering.)
Civil; Electrical; Mechanical; Chemical.

The features of these courses are as follows:

a. In any given engineering college, the studies in the freshman year of all these courses are either identically the same, or so nearly the same, that a student who enrolls in one course and then at the end of the freshman year desires to transfer to another, may do so without incurring any handicap whatsoever.

b. From 50 to 60 per cent. of the specified studies in any course (the percentage being computed on the basis of the time allotted to each subject) are identical with the specified studies in every other course. The greater portion of these common studies comes during the first two years of the courses. Therefore, a student may without loss of credit transfer from one engineering course to another at the end of the sophomore year.

c. The studies which are not common to all engineering courses, but which in any given engineering college are identical in content and type of instruction for all engineering students are listed in Table III. The average time allotted to each study is given in per cent. of the total time in the four year course.

TABLE III.

STUDIES COMMON TO ALL ENGINEERING COURSES.

	Per Cent.
Algebra, Trig., and Anal. Geom.	7
Differential and Integral Calculus	6
Mechanical Drawing and Des. Geometry	6
Chemistry and Qual. Analysis	5
Physics	7
English	4
Statics and Dynamics	3
Mechanics of Materials	5
Thermodynamics	4
Engineering specifications	2
Non-professional electives	8
Total	57 per cent.

d. From 10 to 20 per cent. of the time in the four year course is devoted to studies which in name are common to all courses, but which in content and type of treatment are somewhat different for students in the different courses.

e. The remaining time—from 25 to 40 per cent. of the total time in any four year course—is devoted to studies which are not ordinarily taken by students in other courses.

The fact that the existing courses are identically the same

to the extent of 50 to 60 per cent. of their content is evidence that the common aim is to provide a broad foundation for engineering work in general. In addition to this, each of the courses or options is directed toward one of the *industrial divisions* of the engineering field, or it is intended to give the student a more specific and thorough preparation for work in one of the industrial divisions of engineering. In fact, the courses in mechanical, electrical, and chemical engineering were gradually evolved in the order named, and were added to the original course (civil engineering), in response to the increasing importance of the engineering applications of science in these new fields.

Table IV is an attempt to emphasize a relation between the *industrial divisions* of the engineering field and the *functional types* of engineering work. The functional types have been represented by horizontal bands or compartments and the industrial divisions by vertical columns. The horizontal bands cut through all the vertical columns. That is, the design type of work, for example, runs through all the industrial divisions, or on the other hand, any industrial division runs through or comprises all functional types of work.

As stated above, the existing courses and options (with the exception of administrative engineering) aim to give the student a more specific preparation for work in the field represented by some one of the vertical columns of Table IV, and not a thorough preparation for work in the field represented by some one of the horizontal rows of the table. The preparation of men for engineering research as contrasted with the preparation for engineering supervision or engineering management receives scant and belated consideration in the existing courses.

3. The Grounds for Selection between the Existing Engineering Courses.

The ground upon which a student elects a particular one of the existing engineering courses is that the particular course is directed toward that industrial division of the engineering

TABLE IV.

THE INDUSTRIAL VERSUS THE FUNCTIONAL DIVISIONS OF ENGINEERING.

Industrial Divisions (only a few are listed).

FUNCTIONAL DIVISIONS	Civil.				Mining.			Mechanical.			Electrical.			Chemical.		
	Railway.	Structural.	Sanitary.	Hydraulic.	Mining.	Geological.	Metallurgical.	Steam Power.	Internal Combustion	Heating & Ventilating	Communication.	Electric Railway.	Power Supply.	Gas and Fuel.	Chem. Mfg.	Organic Industrial.	
Sales.....																	
Management.....																	
Supervision.....																	
Design.....																	
Research.....																	

field which for one reason and another makes the greatest appeal to him or to his advisers. Let us now imagine that the existing industrially aimed courses—civil, mining, mechanical, electrical, and chemical engineering—were to be replaced by the functionally aimed courses, engineering research, design, supervision, management, and sales. Clearly, the ground upon which a student would then elect a particular one of these major courses would be that the particular course is directed toward that functional type of engineering work which makes the greatest appeal to him.

In which of these situations—the former or the latter—will the prospective engineer and his counselors, (parental, high school, and university) be called upon and permitted to consider and to choose between the more basic divisions or basic types of engineering—*basic in the sense of being founded upon the natural aptitudes, the peculiar type of intellectual interest, or the type of presentation of the introductory studies which is conducive to the greatest achievement in each division?*

Is not the industrial division which the young man elects, or eventually works into, determined very largely by fortuitous experiences and circumstances? On the other hand, is not the *type* of engineering work into which the man eventually works, determined more largely by innate or natural ability and to a much smaller degree by fortuitous events?

These same questions may be raised in a somewhat different form. Let us imagine a situation in which the engineering educators are so deeply impressed with the importance of vocational guidance that mature educators with a broad conception of the diversified needs of the engineering field are studying the characteristics and qualifications of individual students as evidenced by the work and the reactions of these students in small classes in such important introductory studies as engineering mathematics and engineering physics. Can you conceive of anything very constructive resulting from such an ideal provision for personnel work if the advice of the engineering counselors to the student is couched in terms of

the existing major courses of study in language such as the following?

"It seems to us, Jones, that you have the qualifications for a successful career in mechanical engineering and that you would do well to take the mechanical engineering course. In our judgment you should not take the electrical engineering course."

Is it not extremely probable that the advice would be couched primarily in terms of the types of engineering work in some such language as the following?

"It seems to us, Smith, that you have the qualifications for a successful career in engineering supervision or engineering management and that it would be well for you to take either one of the corresponding courses, preferably the latter. In our judgment you are not fitted to succeed in engineering research."

4. General Features of the Functional Engineering Courses as Contrasted with the Features of Existing Courses.

As stated, the expression "basic types or more basic divisions of engineering" is being used in this paper to signify those divisions which are founded upon the natural aptitudes, the peculiar type of intellectual interest, and the type of presentation of the introductory studies which is conducive to the greatest achievement in each division.

Let us consider the general features of courses of study each of which is intended to provide the best foundation for one of these functional divisions of engineering. The names of such courses have been listed in Table I.

One feature in which these courses will, in my opinion, resemble the existing courses is as follows: Under each of existing engineering courses (civil, mechanical, etc.) there are certain options between which a selection may be made late in the course. Likewise, under each of the proposed basic courses, there will necessarily be options between which the student may elect late in the course. Accordingly, Table I contains under each of the five courses, a partial list of the subjects or

the sections of the engineering field in which the student may elect to major late in the four year course, or perhaps in a fifth year. This list of optional majors is very incomplete. Its main purpose is to convey some conception of the field of each functional group of engineers. It will be seen that this list of majors corresponds to the industrial divisions.

The fundamental difference, as I conceive it, between the existing courses and those suggested is this: Under the existing courses all engineering students in any given college receive precisely the same drill in the same subjects for a total period of two years. (All of these subjects do not necessarily come in the first two years.) This is what might be expected in a system in which no attempt is made to classify students in groups other than civil, mechanical, electrical, etc. This classification gives little indication of the aptitudes of the groups, or of the type of treatment of the introductory studies which will be to the best interest of each group. Suppose, however, that the students were intelligently enrolled as students in engineering research, engineering design, engineering supervision, etc. Is it at all likely that precisely the same introductory drill in mathematics, chemistry and physics would be prescribed for all these groups, each of which may now be assumed to be reasonably homogeneous within itself as regards certain professional aptitudes and needs, and to differ markedly from the others? Is it not extremely probable that at least the first two of the three distinct types of treatment listed in Table V would be available to engineering students in physics and in first and second year mathematics?

TABLE V.

TYPES OF TREATMENT OF SUBJECTS OF STUDY.

Profoundly technical treatment.

Adapted to the needs of men with superior aptitude and keen interest in the subject. Object: to facilitate the acquirement of a *profound understanding* of the subject.

Moderately Technical treatment:

Adapted to the needs of men with a moderate aptitude and moderate interest in the subject. Object: to facilitate the acquirement of

skill or *proficiency* in the use or application of the principles of the subject to the *moderate* extent necessary to effective work in the man's natural field.

Non-technical treatment:

Adapted to the needs of men who have either little aptitude for, or a non-professional interest in, the subject. Object: to facilitate the acquirement of a *non-technical appreciation* of the general content, the methods, and the possibilities of the science.

In the existing courses, the advisability of having at least the last two types of treatment for subjects which are introduced in the latter half of the course is recognized. For example, all engineering students take studies which are labeled either electrical engineering or electrical machinery, but the introduction of the electrical group to the subject is invariably of the technical type, while the introduction of some of the other groups is, in many colleges, avowedly of the non-technical type. The profoundly technical type of treatment is made impossible for any group because of the prevailing (though not universal) practice of not differentiating in any way in the early electrical studies of the students enrolled in electrical engineering.

In the customary administration of the important introductory engineering studies, mathematics, physics, and chemistry in the existing courses of study, there is no recognition of these three types of treatment. Administratively, all engineering students (including those in the administrative engineering courses) look alike for the purpose of the first enrollment in mathematics. Well before the end of the first semester, the instructors have the students classified as of all shades of gray from black to white. But administratively, that is, in so far as provision in the curriculums is made, there are no grays. For the purpose of enrollment in the second semester there are two colors only: white (excellent, good, fair, poor, and condition)—and the whites all look alike—and black (fail). And thus the work in mathematics is administered for a period of two years. That is, during this entire period there is provision for but one type of mathematical course—a course in

which the treatment is a compromise between the first and second types of Table V. (It should be understood that this is a presentation of the features of the existing *curriculums*, which of necessity are somewhat inflexible. It would be a gross misconception to suppose that the same inflexibility characterizes the work of the instructor with his students.)

The introduction to mathematics or to physics which is suited to the needs of the engineering management group is not suited to the needs of the engineering research group. The compromise course in mathematics is neither adapted to the needs of the men with superior mathematical aptitude nor to those with moderate aptitude. The situation is about as follows:

a. The growth along mathematical lines of the upper 15 per cent. of the men in *freshman mathematics* (the excellents and high goods) is stunted by reason of the trivial nature of much of the class discussion.

b. The course is fairly well adapted to the next 15 per cent.

c. If the customary courses in engineering mathematics were made more *moderately technical* by eliminating from 30 to 50 per cent. of the present content, and if the time thus made available were devoted to practice in the application of the fundamental mathematical methods to the simpler engineering problems, the next 30 to 40 per cent. of the class might be expected to become moderately proficient in the use of the simple methods.

d. The remaining 30 to 40 per cent. of the freshman class are so lacking in analytical ability, or in quantitative sense, as to be unsuited for even the moderately technical treatment of mathematics outlined in the paragraph above, and are out of place in an engineering college.

In my opinion, this is a fair statement of the conditions obtaining under the industrially aimed courses. The situation is generally recognized and acknowledged, and in the past discussions of engineering education before this society there was frequent reference to "the educational crime of keeping the able students back at the level of the lowest in the

class." Numerous small scale attempts have been made from time to time to improve the conditions, and are still being made. Yet the situation continues to exist, and there is no large scale or concerted move to remedy it.

It seems hardly possible that educators could work under courses entitled engineering research, engineering design, engineering management, etc., for a score of years and be so backward in making provisions for the great range in student aptitude as to offer after all these years but one introductory course in engineering mathematics and physics.

The distinctive general feature of the functional engineering courses should be the separate provision for the needs of men of superior aptitude and for those of moderate aptitude by profoundly technical and moderately technical treatments of the different branches of science, particularly of the introductory mathematics and physics of the first two years.

5. Distinctive Features of Each of the Functional Engineering Courses, and the Conditions Attending the Transfer from one Course to Another.

If the proposals of the last section are well founded, it would seem that the guiding consideration in laying out the courses would not be the thought that the student cannot be certain that he has elected the proper course, and cannot be wisely directed during the first half of his college career, and that the courses should, therefore, be identical in content for as many years as possible to facilitate the transfer from one course to another. Rather, the consideration would be that the courses should be adapted to the aptitudes of the students, and should, therefore, differ from the very beginning in content and in aim. Facility of transfer in the sense of bookkeeping facility in satisfying rigid graduation requirements should be a minor consideration.

A proposal as to the studies of the first two years is contained in the following schedule:

ENGINEERING COURSES.

Proposed Schedule for Functional Courses.

Freshman Year.

	1st Semester	2d Semester
Alg., Trig., and Anal. Geom. * *	5 cr.	5 cr.
Chemistry * *	4 "	4 "
Mechanical Drawing *	3 "	3 "
English *	3 "	3 "
Human Progress	3 "	3 "
Total	18 cr.	18 cr.

Sophomore Year.

Calculus * *	4 cr.	4 cr.
Physics * *	5 "	5 "
Non-professional electives	4 "	4 "
Varies from course to course * *	5 "	5 "
Total	18 cr.	18 cr.

In those studies marked with a single asterisk, the treatment would be of the moderately technical type. In those studies marked with the double asterisk, the profoundly technical and the moderately technical types of treatment would be available, and the profoundly technical type would be specified in certain courses. For example, the profoundly technical type of treatment in chemistry and physics would undoubtedly be specified for all men enrolled in engineering research. The moderately technical treatment of mathematics would be accepted for men enrolled in engineering supervision, but these men would be perfectly free to enroll for the profoundly technical mathematics, *provided* only that they display superior aptitude for and interest in the study. In those studies not marked with an asterisk, the non-technical type of treatment might well be acceptable.

By the study entitled "Human Progress" scheduled for the first year is meant an initiatory course for freshmen, the features of which are being evolved at a number of universities.*

* See "The Report of the Committee on Initiatory Courses for Freshmen," *Bulletin Am. Assoc. of Univ. Prof.*, Oct., 1922.

This course goes by such names as, or contains such topics as, "College Aims," "Introduction to Contemporary Civilization," "Introduction to Reflective Thinking," etc. The non-professional elective studies of the sophomore year are to be elected from the languages, literature, history, philosophy, psychology, economics, sociology, biology, or political science.

It will be seen that there are no insurmountable barriers between the proposed courses during the first two years. For example, a man who for two years has been content with the moderately technical treatment of mathematics and physics and who then undergoes a new birth may transfer to the course in engineering research, *provided* he has done thorough work in the moderately technical treatments and is ready and able to pay the price in effort.

In the third and fourth years, the courses would differ more and more. Perhaps a common requirement for all courses should be three or four credits of elective studies each semester from the non-professional group listed. The feature of the research course would be the requirement of the profoundly professional introduction to a number of branches of physical science. There would undoubtedly be free electives in the fourth year which would permit a man to concentrate in the field to his liking. The engineering management course would be at the other end of the line from engineering research in that it would accept the non-technical treatment of the physical science and manufacturing arts studies to a greater extent than any other course, and it would require more studies than any other course along business and sociological lines. As regards the moderately technical type of treatment, the engineering sales course would be between engineering supervision and engineering management. In the latter half of the third year, students in engineering supervision would undoubtedly start to major, choosing between manufacture, construction, and operation.

THE DETERMINATION OF APTITUDE FOR ENGINEERING COURSES.

This proposal for courses entitled engineering research, design, management, etc., will be criticized on the ground that it is impossible for the student or his counselors to determine, in less than a year, in which of the courses the student should enroll. It seems to me that the problem with which the student and his counselors are confronted is far simpler than this. The first question to be answered is this: Has the student the aptitude for the type of engineering work for which a college can prepare him advantageously? If this is affirmatively answered, the questions to be answered for the first year are as follows: Is the student's aptitude for, and interest in, Algebra or Calculus or Chemistry or Physics such that he should take the profoundly technical or the moderately technical course in the subject in question?

The answers to the first of the questions may now be had in no very uncertain terms within two weeks of the opening of the school year. For example, all freshman engineers at Wisconsin are given a two weeks review in algebra followed by an examination. Students who fail to pass this examination are placed for a semester in sub-freshman algebra. From 25 to 35 per cent. of the students in the entering class are required to take this sub-freshman algebra. Of this sub-freshman group, about 45 per cent. drop out by the end of the first year, and the percentage qualifying for the degree is quite low. There is no question but that carefully devised and interpreted entrance examinations and tests will indicate with great certainty a large groups of applicants who would be clearly out of place in an engineering college.

7. CONCLUSIONS.

The issue raised in this paper will be clouded if the ground or criticism is that the names engineering research, design, management, etc., are misleading and unwarranted, because it is impossible to teach research, design, or management in a college. A criticism of this type indicates a grave misunderstanding of the aims and claims of educational work. The

growth of the individual is never a symmetrical expansion. Growth has direction, and the aim and the claim of engineering education should be to lay the best foundation for the type of work in which the boy seems to have an interest, and for which he seems to have the aptitude. There is no claim that a student who has taken a four or a five year course in engineering design, and who may, perchance, have been granted the degree, B.S. in Engineering Design, is a full-fledged engineer. But there is, or there should be, a claim to the recognition of aptitude and the development of talent.

It is, perhaps, unnecessary to say that there is nothing magical about the names engineering research, engineering design, etc., as the titles of courses except that such divisions would facilitate the provision of types of treatment better adapted to the needs of the student groups. That is to say, it would be possible to have courses thus named in which there would be no more administrative provision for the recognition of aptitude than in the existing industrially aimed courses. The important thing is the provision of the profoundly technical and the moderately technical types of treatment. This provision can be made within the existing courses. As an illustration, while it would be simpler to lay out a course in Engineering Research, Electrical Option, provision can be made for an identical course (a course in Electrical Engineering, Research Option) within the existing lines of organization of the Engineering Colleges.

This paper is avowedly a plea for the recognition of the necessity for a certain type of specialization in engineering education. If the merits of the proposals are to receive judicial consideration, the indiscriminate use, in educational discussions, of the term *specialization* as a term of condemnation must be abandoned. It must be recognized that there are both good and bad aspects to specialization, and that there are kinds of specialization which on the whole are good, and other kinds which are bad. A bad kind of specialization is that typified by an extensive descriptive treatment of detailed matters of engineering practice.

In the ardor of the crusade against the bad kind of specialization, evils in education which happen to have their origin in the conditions which necessitate specialization in the practice of engineering are, in uncritical fashion, attributed to specialization. As a matter of fact, the evils in question arise from the fact that the course of study is not specialized enough. The evil referred to is the inclusion of too many studies in a course of study, or of too much subject matter in each study. The origin of this practice is the desire to give the student a broad preparation for the work of the engineer. It arises from a desire to avoid specialization. Yet the superficial work which results is vaguely attributed to, or associated with, specialization; whereas, the remedy for the superficial work is specialization in the sense of preparing for a specific type of work. To illustrate, a partial remedy for the lack of proficiency among engineering graduates in the application of mathematics to the problems encountered in engineering practice is specialized courses in mathematics—a profoundly technical course adapted to the needs of the few, and a moderately technical course adapted to the needs of the many. This lack of proficiency is, perhaps, the most striking evidence that the existing course as at present administered are not intended for—or at least do not lend themselves to—the effective training of engineering specialists.

Rightly conceived and correctly administered, specialization in the sense of encouraging concentration, and mastery, and leadership through achievement, in some field of activity, is a remedy for, rather than a cause of, superficial habits of thought. If it is feared that leadership achieved in this manner will be accompanied by narrowness of vision, the question may well be raised as to which is the more important to clearness and trustworthiness of vision—is it the type of insight which is gained in broad surveys of general outlines, or is it the type of insight which is gained in broad surveys of general outlines, or is it the insight which comes from the discipline necessary to the achievement of mastery in narrower fields?

A FORGE WORK COURSE FOR ENGINEERS.

BY LUTHER C. SCOTT,

Associate Professor of Industrial Education,

University of the City of Toledo.

The following course in forge work has given good results during its five years of trial at the University of Toledo and has been commended by mechanical and metallurgical engineers as being in line with the needs of engineers in modern industry.

It is based on the same methods of organization that are used in building up a course in chemistry or any other science. Emphasis is placed upon the student's mastery of principles and his ability to think in principles rather than upon his acquirement of a large amount of data or the attainment of any particular degree of skill.

The work is conducted on a laboratory basis, using lectures, assigned problems and oral and written tests, as well as practice in forging operations, the latter being used only to supplement and illustrate the subjects being studied.

The course begins with a study of grain structure, hardening, tempering and annealing, and the structural composition of steel within the transformation range. Then the carbon-iron diagram is carefully and minutely analyzed, but only so far as it concerns iron and steel—Cast Iron and other compositions of over two per cent. of carbon is studied later in the foundry class—the composition and percentages of cementite and pearlite, high and low carbon steels, and thermal critical points. Reference is here made to the general effect of nickel, chrome, molybdenum and tungsten. Only fundamental and elementary principles are touched upon, but a clear knowledge of these principles is required, and this clear understanding is made the measure of how far into these and

the following subjects each individual class is able to go in the time allotted.

Crystalline structure is next taken up. Crystal formation within the grain, amorphous metal, elastic limit, yield point, ultimate strength, cold working as illustrated in wire drawing, and carburization. Each student polishes and etches two or three specimens, examines them and many others under the microscope, and in this way becomes familiar with all of the more common types of grain structure.

The latter part of the course covers the basic principles of the making of pig iron from the ore, its refinement into steel, rolling mill equipment and processes, power hammer and hydraulic press operations, drop forging and commercial methods of hardening and heat treating. This part is conducted principally as a lecture course, using lantern slides, but includes oral and written tests.

The practice work begins with a study of the grain structure of hardened tool steel. Each student is furnished with a small bar of steel, of a quality which hardens to the finest grain at about 1400° F. He keeps the end drawn to a square and practices hardening and breaking the end until he is thoroughly familiar with the correct hardening heat and with the appearance of the grain of varying heats. To make this subject more clear, a piece of flat steel is used, which was quenched when one end was at a white heat, the other end cold, then broken lengthwise, thus showing in cross section the grain structure produced by different degrees of heat. The corresponding hardness also being illustrated by the file test and by use of the scleroscope. This practice work is accompanied by lectures (noted above) in which is explained the factors affecting grain size and grain growth, the effect of right and wrong hammering, and includes minute directions how to forge a chisel.

The student next practices in drawing temper colors on a piece of soft steel, shaped like a chisel, until he can be depended upon to secure a purple color two inches long on the end, with blue on the body side of the purple. He then

dresses, hardens, tempers and grinds a chisel. If this chisel can be broken or bent in chipping steel by heavy blows with a five-pound hammer, as is usually the case in the first one or two trials, its defects are noted and the practice continued. Usually on a third or fourth dressing the chisel will stand the test. By this time the class is thoroughly interested. They feel that they are doing real work and know that they understand the essential details of each operation. Some general forge work follows which is designed to give a knowledge of welding, upsetting, bending and the use of the more common hand tools,—hardie, fuller, etc. In a recent class of sixteen, every man succeeded in making a punch which, sharpened to a point, stood driving with a twelve-pound sledge through cold Norway iron one inch in thickness.

To the equipment ordinarily found in school shops is added a gas forge, pyrometer, scleroscope and metallurgical microscope. The gas forge and microscope have been found to be the most helpful of the additional features. The polishing apparatus is merely two flat cast iron disks mounted on an ordinary emery wheel stand. Both sides of one disk are covered with emery paper, the other disk with broadcloth. A Bausch and Lomb F M 3 metallurgical microscope, fitted with a Tassin illuminating apparatus, is used. The cost of the entire metallographic outfit was about one hundred dollars. The textbook used is "The Making, Shaping and Treating of Steel," by Camp and Francis, published by The Carnegie Steel Company.

The course is covered in one semester, four hours each week, for which two credit hours is given. The classes are composed entirely of engineering students, mostly freshmen, and all are high-school graduates.

THE CONFERENCES ON ENGLISH.

The two conferences on English to be held in connection with the Boulder meeting of the S. P. E. E. will afford opportunity for the discussion of the place of English in the educational scheme of our engineering colleges from two distinct viewpoints. The joint conference of the Committee of Deans and the Committee on English, set for 8:30 Friday morning, should result in an exchange of ideas on this important subject which will prove profitable both to the deans and to the teachers of English themselves. The second conference planned for Saturday morning is intended primarily for teachers of English but anyone interested is welcome to attend. In addition to these two meetings, the Committee on English itself plans to be in session every day during the Convention at an hour to be announced later. It is their intention to work out into more satisfactory form the syllabus on the teaching of English which they hope to publish soon. Any teacher interested will be welcome at these committee conferences.

The outline of topics for discussion at these conferences is not in final form, but will indicate roughly the objectives of the Committee.

The Joint Conference of the Deans and the Teachers of English.

The chairman of the Committee on English will have ready a brief digest of the material provided him by his recent correspondence with more than one hundred deans, indicating the present status of English in the engineering schools. It is thought this may be of value both to the deans and to the teachers of English present. It has not seemed best, however, to make this the basis for discussion, for there are so many questions on which the Committee is eager to hear our deans speak. The following outline has, therefore, been made cover-

ing three subjects vital to us all, the place of English in the curriculum, the kind of training in English needed, the teacher of English as a factor in the problem.

The Place of English in the Training of Engineering Students.

1. How many hours of work in English prove a sufficient requirement?
2. How can the training in English be made a matter of continuous and constant growth on the part of the student?
3. How can it be coördinated with the other work he is doing?
4. How can the real importance of his English as a preparation for his professional work be made vital to him?
5. How can his deepest and most genuine interests be enlisted for this work?

The Kind of Training in English Needed by Engineering Students.

1. Should the practical or the ideal values of English be most largely emphasized?
2. What proportion of the time available should be devoted to training the student to write and speak? What proportion to interesting him in reading and to developing his ability to appreciate literary values?
3. Shall our objectives be accuracy in the use of English, or appreciation and taste, or both?
4. Should the courses in literature be compulsory or wholly elective?
5. Should the courses in literature deal in a systematic way with the history of literature, or should they aim rather to develop interest and critical appreciation?
6. Is the sectioning of students according to ability to be commended?
7. If the coöperation of the entire engineering faculty could be secured in training the student to be accurate in his use of English, more of the time of the English teachers could be devoted to interesting him in good reading and giving him critical standards. How can the entire engineering faculty be enlisted in the cause of good English? What plans of coöperation can be used?

THE TEACHER OF ENGLISH IN RELATION TO THE PROBLEM.

1. How can teachers be secured who are willing to study sympathetically the point of view of the engineering student and of the engineering educators as well, and who are willing to identify their interests with those of engineering education?
2. Is there evidence that an increasing number of teachers of English are evincing interest in this rather specialized field of service?
3. What inducements can we offer in this field to increase the supply of desirable teachers of English?
4. What advantages are there in making the teacher of English a member of the engineering faculty? Are there any disadvantages for either the teacher or the engineering school?
5. Are salaries, in general, large enough to offer a sufficient inducement to the best man?

CONFERENCE OF TEACHERS OF ENGLISH.

The Committee on English has decided not to publish its syllabus on the Teaching of English to Engineering Students until after the meeting at Boulder. It is, therefore, making the preparation of that syllabus the basis for discussion at the conference of teachers to be held Saturday morning. The outline which follows will suggest the general plan and the range of subjects to be covered. All teachers who expect to be present are urged to come prepared to contribute in every possible way to the material for the syllabus.

I. Classification of Freshmen.
   - *A.* On entrance.
     1. By examination.
     2. By a week of test work.
   - *B.* At the end of a probational period.
     1. Two weeks.
     2. Six weeks.
     3. Eight weeks.
   - *C.* After postponement of English 1.
     1. To the second semester.
     2. To the second year.

II. Supplementary Work.
   - *A.* To precede English 1—Sub-freshman work.
   - *B.* To accompany English 1—Supplementary work.
   - *C.* To follow English 1—Make-up work.

III. Courses in English Composition.
  A. Required courses.
    1. English 1. 2. Follow-up work.
  B. Elective courses.
    1. General.
    2. Specialized courses.
      Business English, Commercial Correspondence. Reports, Scientific Papers, Technical Journalism.
IV. Courses in Literature.
  A. Systematic courses in the history of literature.
    1. English. 2. American.
  B. Courses in the appreciative and critical study of modern literature.
    1. General introductory courses.
    2. Foreign literature courses in English.
    3. Special courses in the drama, novel, short story, and scientific literature.
  C. Supplementary reading lists.
V. Combination Courses.
  A. English and History.
  B. English and Economics.
  C. English and Government.
  D. English and Logic.
VI. Plans for Checking Students' Careless Habits of Expression.
VII. Plans for Securing Coöperation of Entire Faculty.
VIII. Senior English Courses.

The Committee on English urges that wherever it is possible all colleges of engineering see to it that some representative be present at the conferences on English. These meetings for the past two years have been very profitable and have done much to clarify our understanding of our problem. It is hoped that this year's conference may prove still more definitely constructive in its results.

Address suggestions and criticisms to J. Raleigh Nelson, 927 Forest Ave., Ann Arbor, Michigan.

REPORT OF COMMITTEE NUMBER TEN, MATHEMATICS.

The chairman regrets that for various and good reasons the committee has not been able to meet. The committee suggests that next year a number of papers or at least brief statements be secured from the deans of representative colleges on the nature and extent of the mathematical curriculum. The extent may preferably be given as percentage time of the four year time allowed for mathematics as such (not including mathematics in Mechanics, etc.). It will be found that the percentage varies in different fields of Engineering Education in the same college. When such variations in a college exist it would seem desirable to learn the reason.

ERNEST J. BERG,
Chairman.

REPORT OF COMMITTEE NUMBER TWENTY-FIVE, SAFETY.

In 1918 conferences of prominent engineering educators and officers of the National Safety Council were held in New York and Chicago and the recommendations of these conferences led to the publication of two pamphlets by the Council for the use of engineering colleges. This coöperation undoubtedly led to formal recognition of safety instruction by the S. P. E. E., February 1, 1923, in the appointment of a new committee of the Society, Committee on the Fundamentals of Safety Training, to be known as Committee No. 26. (Subsequently this was changed to Committee No. 25—Safety.) The duty of this committee is to prepare a report on the best methods to use in teaching the fundamentals of accident prevention, and at the 31st Annual Meeting of the S. P. E. E. in Ithaca, New York, which Mr. S. J. Williams, Chief Engineer for the National Safety Council was good enough to attend, the Safety Committee discussed the above problem.

Prior to this Cornell meeting, a brief questionnaire containing the following questions was mailed to one-hundred of the leading technical institutions in the United States and Canada:

1. Is the equipment of your shops and laboratories guarded according to recognized safety standards, such as state labor department or insurance requirements?

2. Is any attention given to safety, in lectures or class room instruction, and, if so, in what courses?

Replies were received from 72 institutions containing data as follows:

In answer to question 1:

3 institutions have no laboratory equipment.
3 institutions do not have their equipment guarded at all.
16 institutions have their equipment only partially guarded.

49 institutions have their equipment guarded in conformity to recognized safety standards.

In answer to question 2:

6 institutions do not give any attention to safety.

37 mention safety practices casually in connection with such courses as machine design, shop work, laboratory work, etc.

23 institutions make a special attempt to include lectures on safety in connection with shop work, courses in industrial management, mining engineering, electrical and mechanical engineering laboratory instruction, etc.

6 institutions go beyond this latter point in certain courses and feature safety principles and practices.

It was the consensus of opinion of those who attended the committee meeting, as well as those who wrote to the chairman of this committee, that courses leading to the degree of Bachelor of Science in Safety Engineering were unnecessary, undesirable and impracticable. They further agreed that there was no room in our present curricula for special courses in safety principles, and that such courses would be undesirable for most colleges. It was brought out, however, that the technical colleges are far behind industry in their "safety attitude," and that the progressive industries of to-day consider safety as an essential part, although a small part, of industrial management and industrial engineering. It was felt that engineering students should not be exposed to unguarded machinery nor taught unsafe methods so that they come out of college with ideas and habits antagonistic to the accepted standards of industry.

After discussing some of the safety features as given by various colleges, the following recommendations were drawn up:

1. The committee recommends that emphasis be placed on the guarding of physical apparatus and equipment to conform to standard requirements both in shops and laboratories in order to impress upon the students the safety point of view. The details of safety devices and requirements should prefer-

ably follow the state requirements when such exist; and where there are no state requirements, to follow the national codes which can be obtained from the National Safety Council, 168 North Michigan Avenue, Chicago, Illinois.

2. The committee believes that it would be well to include a minimum of two lectures or recitations on accident prevention in courses given in industrial organization and management.

3. The committee believes that it would be desirable to include the idea of safety as one of the factors to be taken into consideration in design courses, such as:

A. Machine Design,
B. Electrical Design,
C. Building Design and Construction,
D. Hydraulic Design, etc.

Charles F. Scott, Past President of the S. P. E. E., in outlining the work of this committee, stated certain points which need further consideration and discussion.

1. A basis should be laid for a rational program for safety instruction in the colleges. It is quite likely that this will not be a fixed course, but rather the cultivation of an attitude on the part of instructors and students toward the general subject of safety.

2. Presumably printed reports and charts of the National Safety Council, possibly selected and supplied to the reading rooms and bulletin boards of colleges, will be potent factors in disseminating safety education.

3. Some means should be determined upon to interest students in the subject of safety, so that they will make investigations of their own account and read papers on the subject to their fellow students.

4. It would be well to consider a plan by which the National Safety Council could publish small booklets that would describe safety methods for different types of laboratories and shops connected with engineering schools. These could be issued to the students when they begin their labora-

tory work, cautioning them in the language of the industrial safety codes against the hazards to which they are exposed in their experimental work. These pamphlets would serve the double purpose of inculcating the safety idea and informing the students as to where safety measures are demanded in industry.

Mr. S. J. Williams has offered the following outline for methods of safety instruction:

1. Lectures by outsiders at general assemblies of students or in classes in the various related subjects.
2. Principles of safety incorporated in regular courses in industrial management, machine designing, mining, etc.
3. Safety taught and practiced in shop or laboratory work.
4. Physical equipment of colleges brought up to current standards.
5. Field inspection by students.
6. Faculty safety committees.
7. Safety exhibits both permanent and special with the liberal use of bulletin board reports and charts.

It is certain that our colleges are not giving the instruction in and attention to accident prevention that the subject deserves, and in this attitude we are far behind industry. The wealth of literature that has come forth during the past year is somewhat a measure of the importance given to this subject by industry. The October 1923 issue of American Industries was given over to articles on safety. The A. S. M. E., the Bureau of Standards, the Bureau of Labor Statistics, and the National Safety Council have recently published valuable pamphlets on safety, all approved by the American Engineering Standards Committee.

Some of our technical colleges which are doing good work in safety are: State Agricultural College of Colorado, Columbia University, University of Illinois, University of Minnesota, Pennsylvania State College, and the University of Cincinnati. The University of Cincinnati offers a course of ten lectures on Safety and First Aid which is compulsory for all freshmen coöperative students. The Pennsylvania State College offers

a course in Industrial Relations, required of all industrial engineers, a goodly amount of time being spent on safety principles, accident prevention, and workmen's compensation laws. The laboratory work in this course includes inspections of local plants, methods of plant rating according to national insurance standards, and an inspection report covering safety recommendations. The University of Minnesota offers an elective course in Safety Engineering. They also offer a required course covering safety principles and practices for men who specialize in the industrial engineering courses.

The University of Illinois, however, pays more attention to safety than any other college brought to the attention of this committee. All equipment in the shop laboratories is fully guarded. Instruction in the principles of safety is given considerable prominence in shop laboratory instruction. Lectures are given on the subject, and the responsibility for accidents and the conditions that cause them is placed squarely upon the student through the medium of (*a*) a group of Safety Assistants, and (*b*) a safety organization known as the "Life and Limb Club." During some period of the course, the student is required to serve as Safety Assistant and for eight laboratory hours he studies the question of safety from several different angles. The work of the Safety Assistant is outlined in an instructional manual. Illinois follows closely the outline as recommended above by S. J. Williams, with extensive use of bulletin boards and exhibits.

It is hoped that the National Safety Council will shortly publish a new pamphlet on Safety for distribution among the engineering colleges, and that the colleges will consider it worth while to place more emphasis on the "safety attitude."

C. J. Tilden,
R. M. Raymond,
H. J. Hughes,
F. P. McKibben,
M. E. Cooley,
W. T. Magruder,
J. O. Keller, *Chairman.*

REPORT OF COMMITTEE NUMBER TWENTY-SIX, TO COÖPERATE WITH THE RAILROADS.

The Committee to Coöperate with the Railroads is able to make at this time merely a brief report of progress.

The Committee was appointed in November of last year. After some preliminary correspondence concerning the purposes of the Committee, it held its first meeting in Chicago on March 12th. At that meeting there were present with us, Mr. R. H. Ford, Chairman, and Mr. H. R. Safford, a member, of the American Railway Engineering Association's Committee XXIV on Coöperative Relations with Universities and Colleges of the United States and Canada. This Committee's purposes are similar to our own and we are fortunate in having enlisted their coöperation.

At this first meeting there was further discussion of the aims and purposes of the two committees; and since these include a desire to stimulate the interest of college graduates in railway service, and to stimulate the railroads to try to attract a larger proportion of graduates, it was suggested that both committees would benefit by having a joint meeting at which we might hear the views of William E. Wickenden, the director of Investigations of the Society.

Mr. Wickenden having consented to this arrangement, the second meeting of the Committee was held in Chicago on April 25th. This meeting was again attended by Mr. Ford and by three other members of the A. R. E. A. Committee; and after some preliminary discussion, Mr. Wickenden outlined his views as to how the two committees might make a survey of conditions on the railroads which would be useful in carrying out the purposes above cited.

The committee will continue to coöperate with A. R. E. A. Committee XXIV, and we hope during the next few months to further define our purposes and to be able to take some steps toward their realization.

EDWARD C. SCHMIDT,
Chairman.

SECTIONS.

The **Minnesota Section** of the Society for the Promotion of Engineering Education held its fourth meeting of the year in Room 201, Men's Union, on Tuesday, April 8, 1924.

Professor F. W. Springer, of the Department of Electrical Engineering, read a paper on the subject, "At What Are We Aiming And With What?"

Professor Springer's paper was followed by a discussion in which the following members participated: Dean Leland, Dean Dowrie, Professor W. F. Holman, Professor W. E. Brooke, Professor Frederick Bass.

The meeting adjourned at 8:00 o'clock.

H. B. WILCOX,
Secretary.

The spring meeting of the **New England Section** of the Society for the Promotion of Engineering Education was held at Sheffield Scientific School, Yale University, New Haven, Connecticut, April 5, 1924. Most of the members from the East and North left Boston upon a special car attached to the regular train arriving at New Haven about 5 P.M., April 4.

The morning of April 5 from 8:00 to 11:00 was occupied with registration at Dunham Laboratory and visits to the various Engineering buildings and laboratories.

The business meeting was called to order at 11:15 by Dean Anthony. The records of the previous meeting held at Rhode Island State College October 27, 1923, were read and approved, after which the Chairman called for the customary reading of the constitution. The Nominating Committee which had previously been appointed reported and recommended that the following officers be elected for the ensuing year:

Chairman, Dean Gardner C. Anthony, Tufts College.

Secretary, Dean Harold S. Boardman, University of Maine.

The report was accepted and adopted.

Dean Votey gave a cordial invitation to hold the fall meeting at the University of Vermont and set the tentative date of Saturday, October 11. The invitation was accepted.

The Chairman then introduced Dean Warren, who gave a very pleasing address of welcome.

Professor Hastings gave a very interesting talk upon "Administrative Engineering." He explained in detail the curriculum in Administrative Engineering at Sheff. and discussed Scientific Management and Personnel Systems in the intelligent handling of the individual.

Professor Chapman, of the Department of Education, talked upon "Educational Matters."

These addresses were much appreciated by the members, and the request was made that they be reduced to writing in order that they might be published in the BULLETIN at a later date.

At 12:20 o'clock the Chairman announced the "Safety Valve" for members. From this time until 1:00 o'clock the valve blew off, at which time an excellent luncheon was served upon the main floor of Mason Laboratory.

The afternoon session was called to order by the Chairman at 2:40 P.M. The first speaker was Provost Graves who gave a very interesting brief talk concerning the objectives towards which the Society could spend their efforts. The Chair recognized Professor D. C. Jackson, who presented the following resolution which was unanimously accepted and adopted:

Resolved: That the New England Section of the Society for the Promotion of Engineering Education hereby unanimously expresses its appreciation of and thanks for the entertainment and hospitality extended to it by Yale University.

The next and last speaker on the program was Mr. Wickenden, who gave a very complete up-to-date report upon his activities during the past few months. He summarized his recent visits to Engineering schools and explained the revised

program of his proposed activities of the future. At the end of his remarks an animated discussion followed.

The meeting adjourned about 5:30 P.M.

The following Institutions were represented:

Yale University,
Tufts College,
Harvard University,
Trinity College,
Franklin Union,
Norwich University,
Mass. Institute of Technology,
Brown University,
University of Vermont,
University of Maine,
Wentworth Institute,
Pratt Institute,
Northeastern University,
New York University.

H. S. BOARDMAN,
Secretary.

COLLEGE NOTES.

Highway Engineering and Highway Transport Courses.

Summer Session—June 23 to August 15, 1924.

University of Michigan.—Highway Engineering Theory and Economics, and Highway Transport Surveys (Civil Engineering 41). Highway Transport Economics, Methods, Legislation and Management (Civil Engineering 44). Civil Engineering 41 and 44 may be taken for credit in the Graduate School or in the College of Engineering. The Davis Library of Highway Engineering and Highway Transport will be available for research work during the Summer Session.

Fees: The fee for the Summer Session in the College of Engineering is $32, regardless of the number of courses taken. In the Graduate School, the fee for men who are matriculates is $32, and for non-matriculates, $37. The fee includes membership in the Michigan Union during the Summer Session.

Regulations: Prospective students are advised to obtain from the Secretary of the Summer Session a copy of the 1924 Announcement and read the regulations on pages 23 to 27.

Information: Men who intend to enroll in the highway engineering and highway transport courses or desire further information should write to Arthur H. Blanchard, 1026 East Engineering Building, University of Michigan, Ann Arbor, Michigan.

PAN AMERICANS TO STUDY OUR HIGHWAY TRANSPORT.

Forty representatives from twenty Latin American countries will make an intensive field study of highways and highway transport in the United States early this summer as guests of the Highway Education Board. Dr. John J. Tigert, Chairman of the Board and United States Commissioner of Education, has announced that the countries from which representatives will be chosen include Argentine, Bolivia, Brazil,

Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Salvador, Uruguay, and Venezuela. The delegation will be known as the Pan-American Highway Commission.

The Highway Education Board proposes to conduct the Pan-American visitors, who are to be men of broad experience in highway affairs in their respective countries, on a survey of approximately three weeks' duration through several of the more progressive states of the Union, mostly by automobile, so they may learn first hand what our vast experience in highway building and in highway transport has taught the engineers and economists of this country. It is believed, too, that the visit will result in an interchange of thought and experience that will prove mutually helpful and beneficial to all the governments affected.

BOOK REVIEW.

The Principles and Practice of Surveying. Volume I. Elementary Surveying. CHARLES B. BREED AND GEORGE I. HOSMER. Fifth edition. 5 x 7½ in.

The latest edition of this well-known textbook in elementary surveying is similar in general make-up to the preceding edition. It is pocket size and bound in flexible covers, retaining however the original large size type, a feature of great value in classroom and field work. There is an absence of fine print notes. A new chapter on stadia and a Stadia Reduction Table has been added. The chapters on Mine Surveying, City Surveying, Calculation of Traverses, and Observation for Meridian and Latitude have been revised. Each chapter is followed by a series of problems which are of material aid in the teaching of the subject. Numerous illustrations and drawings clearly illustrate the instruments and methods used. These drawings are exceptionally well made. In general the text is sufficiently complete to bring out clearly the principles and methods necessary for the average student without excess of verbosity so disliked by the engineering student.

L. W. McI.